11 SCC in Integrity Management

11.1 Scope Statement

"Develop a practicable procedure regarding how to assess SCC in operating pipelines within the context of integrity management."

This work item is addressed first in Chapter 10 and concluded in this Chapter.

11.2 Assessment of SCC Risk Factor in Integrity Management Plans

The OPS Integrity Management Plan protocols establish the general procedure for regulatory oversight of an operator's Integrity Management Plan.

11.2.1 Natural Gas Pipelines – Protocol Review

There are four draft OPS Gas Integrity Management inspection protocols that specifically mention SCC. The first of these is Protocol C.1, Threat Identification. Item a. states:

"…verify that at least the following nine categories of threats have been evaluated:

   i. Time-dependent threats: (1) external corrosion, (2) internal corrosion, and (3) stress corrosion cracking;…"

The next two are Protocol D.12, SCCDA Data Gathering & Evaluation, and Protocol D.13 SCCDA, Assessment, Examination, & Threat Remediation. Protocol D.12 states:

"Verify that the operator's SCCDA evaluation process complies with ASME/ANSI B31.8S, Appendix A3 in order to identify whether conditions for SCC of gas line pipe are present and to prioritize the covered segments for assessment.

   a. Verify that the operator has a process to gather, integrate, and evaluate data for all covered segments to identify whether the conditions for SCC are present and to prioritize the covered segments for assessment.

      i.   Verify that the operator gathers and evaluates data related to SCC at all sites it excavates during the conduct of its pipeline operations (not just covered segments) where the criteria indicate the potential for SCC.

      ii. Verify that the data includes, as a minimum, the data specified in ASME/ANSI B31.8S, Appendix A3.

      iii. Verify that the operator addresses missing data by either using conservative assumptions or assigning a higher priority to the segments affected by the missing data, as required by ASME/ANSI B31.8S, Appendix A3.2."

While Protocol D.13 states:

ChallengeUs.

"Verify that covered segments (for which conditions for SCC are identified) are assessed, examined, and the threat remediated.

a.   Verify that, if conditions for SCC are present, that the operator conducts an assessment using one of the methods specified in ASME/ANSI B31.8S, Appendix A3.

b.   Verify that the operator's plan specifies an acceptable inspection, examination, and evaluation plan using either the Bell Hole Examination and Evaluation Method (that complies with all requirements of ASME B31.8S Appendix A3.4 (a)) or Hydrostatic Testing (that complies with all requirements of A3.4 (b)).

    i.   Verify, that the operator's plan requires that for pipelines which have experienced an in-service leak or rupture attributable to SCC, that the particular segment(s) be subjected to a hydrostatic pressure test (that complies with ASME/ANSI B31.8S, Appendix A3.4 (b)) within 12 months of the failure, using a documented hydrostatic retest program developed specifically for the affected segment(s), as required by ASME/ANSI B31.8S, Appendix A3.4.

c. Verify that assessment results are used to determine reassessment intervals in accordance with §192.939(a)(3); (see Protocol F)."

And the last inspection protocol that references SCC is Protocol F.4, Reassessment Intervals, which states:

"Verify that the requirements for establishing the reassessment intervals are consistent with section §192.939 and ASME B31.8S…"

It goes on to state: "If the reassessment method is external corrosion direct assessment, internal corrosion direct assessment, or SCC direct assessment refer to Protocol D for evaluating the operator's interval determination."

49 CFR 192.939(a)(3) describes the required method for determining the reassessment interval if SCC direct assessment is used, but limits the maximum interval to that specified in AMSE B31.8S, Section 5, Table 3.

Other Protocols that are related in varying degrees to addressing an SCC threat include:

- Protocol B.1, Assessment Methods,

- Protocol F.1, Periodic Evaluations,

- Protocol F.2, Reassessment Methods, and

- Protocol H.6, Corrosion.

A description of SCC and the threat it poses to pipelines is presented in Section 4 of this report. Prevention, Detection and Mitigation of SCC are discussed in Sections 5, 6 and 7, respectively.

The most discussed subject related to SCC in the Protocols is SCCDA. The forthcoming NACE recommended practice on SCCDA is discussed in Section 6.3 and, to a lesser extent, Section 8.2 of this report. A part of the SCCDA process is determining appropriate reassessment intervals.

The use of ILI for detection of SCC is discussed in Section 6.2.

11.2.2 *Hazardous Liquids Pipelines – Protocol Review*

The current Hazardous Liquids Integrity Management Inspection Protocols specifically mention SCC in two locations. Protocol #5.01, Risk Analysis: Comprehensiveness of Approach, states:

"An effective operator program would be expected to have the following characteristics:

1. Inclusion of all relevant important factors that might constitute a threat to pipeline integrity, such as:

   - external and internal corrosion
   - stress corrosion cracking
   - materials problems
   - third party damage
   - operator or procedures errors
   - equipment failures
   - natural forces damage
   - construction errors

2. Inclusion of all important relevant factors that affect the consequences of pipeline failures, such as

   - health and safety impact
   - environmental damage
   - property damage

3. Integration of results from the analysis of how pipeline failures could affect high-consequence areas from the segment identification process."

Protocol #6.02, Preventive & Mitigative Measures: Risk Analysis Application, states:

"Operators must conduct a risk analysis as part of the evaluation of preventive and mitigative measures, including a number of specific risk factors. In addition to the required set of factors, there are other factors that are relevant to the preventive and mitigative measures evaluation. An effective operator program would be expected to have the following characteristics:

1. Consideration of all risk factors required by §195.452(i)(2) in the risk analysis applied to the preventive and mitigative measures evaluation. If all required factors are not considered, a documented basis provided for the exclusion of certain listed factors.

2. A risk analysis process that addresses all other relevant factors that constitute a threat to pipeline integrity (e.g., external and internal corrosion, third party damage, operator or procedures error, equipment failures, natural forces damage, stress corrosion cracking, materials problems, construction errors, various operating modes).

3. A risk analysis process that addresses all other relevant important consequences of pipeline failures (e.g., population impacts, environmental damage, property damage).

4. Measures to assure that the analysis are up to date prior to use (e.g., pipeline data and configuration assumptions verified to be current prior to evaluating the relative impact of a proposed preventive or mitigative measure)."

Similar to the Natural Gas Inspection Protocols, there are several other protocols that are related in varying degrees to addressing an SCC threat:

- Protocol #2.01, *Baseline Assessment Plan: Assessment Methods*,

- Protocol #3.05, *Integrity Assessment Results Review: Identifying and Categorizing Defects*,

- Protocol #3.07, *Integrity Assessment Results Review: Hydrostatic Pressure Testing*,

- Protocol #3.08, *Integrity Assessment Results Review: Results from the Application of Other Assessment Technologies*,

- Protocol #4.01, *Remedial Action: Process*,

- Protocol #4.01, *Remedial Action: Implementation*,

- Protocol #5.02, *Risk Analysis: Integration of Risk Information*, and

- Protocol #5.03, *Risk Analysis: Input Information*.

11.3 Specific Protocol Issues to be Addressed Regarding SCC

Based on the protocols discussed above, an operator's IM plan, whether liquid or gas, should contain the following information with respect to SCC:

1. *Data collection Procedure*:

Plan Document: A written program that includes the data required to be collected to evaluate SCC susceptibility; a procedure to collect, collate and maintain such data; a procedure that determines and justifies conservative estimates made in lieu of field data; and procedures, as appropriate, to be used in the data collection methodology and/or qualification of personnel assigned to gather the data.

Comments: Data collection is essential to a robust pipeline integrity management program. For evaluation of SCC susceptibility, such data would include changes in cathodic protection

requirements that may indicate degradation of the coating system. Leak history and failure evaluations can lead to trends in the performance of the pipeline. The presence of SCC as detected by ILI can indicate areas of potential problems. Pressure cycles and the magnitude of pressure cycles during normal and abnormal operation are important to crack growth prediction and remaining life estimates.

There are three general sources of data to consider in examination of SCC: 1) Historical data including leak and rupture history, ILI and hydrostatic tests, 2) Pipe data including geometrical (OD, wall), mechanical and metallurgical properties, as well as the operating characteristics and 3) On site data such as observations from examinations of digs. All three sources of data must be carefully examined to consider the available options.

2. *SCC Threat Assessment Procedure:*

Plan Document: A written procedure for collection and evaluation of information, including data from ILI, past hydrostatic tests and/or direct examination, that operators can use in conjunction with their route mapping and pipeline system operational characteristics to prioritize those segments that may be more susceptible to SCC. This procedure could form part of an operator's linewide threat assessment plan and/or External Corrosion Direct Assessment (ECDA) process as such as defined in Non-mandatory Appendix B of ASME B31.8S. An example of an assessment procedure for high pH SCC is given in the report *Protocol to Prioritize Sites for High pH Stress-Corrosion Cracking on Gas Pipelines*, by Eiber and Leis (1998). The minimum criteria for gas lines is presented in B31.8S, Appendix A3. Evidence of update procedures and the assurance of competent personnel who perform/evaluate the update should be included in the plan document.

Comment: There are a number of approaches that can be used to assess and/or prioritize pipeline susceptibility to SCC, and no single method is recommended above others. Rather, the important point is that a consistent approach is used that includes both the technical factors as well as other societal and environmental factors that contribute to the overall risk of a potential SCC incident. Also, it is important that this procedure is maintained and updated as new technical data is collected, new information regarding SCC is developed, and/or new information regarding the external consequences is received. The viewpoint must be that the procedure is really a methodology to continually refine understanding of the threat posed by SCC.

It is noted that this procedure is also used by the operator to demonstrate that his pipeline is not susceptible to SCC. The mere fact that no SCC-related incident has occurred on a pipeline segment should never be considered as evidence that the pipeline is not susceptible to SCC.

3. *Examination Procedure for SCC:*

Plan Document: A written procedure to be used during direct examination that addresses the identification and examination procedures relative to SCC. It should address factors that will trigger more detailed SCC-specific examination, such as evidence of a disbonded coating during a visual examination. The procedure should identify the data collection effort,

as well as the specifics of the direct examination technique(s) applicable, e.g. surface preparation, types of magnetic particle or dye penetrant, etc. It should also address hydrostatic test procedures.

Comments: See Chapter 6 of this report for additional information.

4. *SCC Evaluation Procedure:*

Plan Document: A written procedure should be evident that shows the steps to be followed when SCC is detected. This should include a fitness-for-service assessment of the pipe segment containing the SCC, possible mitigation and/or preventative steps, as well as a procedural outline for continued monitoring and reassessment.

Comments: Once SCC susceptibility is identified in a pipe segment, it is prudent to establish a focused program to track SCC indications, establish and monitor growth and growth rates, develop a remedial and/or preventative program, and consider investigation techniques such as high-resolution ILI crack detection tools and /or increased hydrostatic testing. Such a program must be well documented, auditable, and consistent with best industry practice.

Testing and/or inspection intervals depend on the growth rate of SCC. Ideally, the retest intervals should be set to detect cracks that will not grow to critical size before the next test. This depends on a clear understanding of the crack mechanism within the operational parameters of the system, as well as an understanding of the crack growth mechanism and its consequent growth rate. Crack growth is calculated using conservative methods so as to predict the fastest crack growth rate. The time to failure is then computed by dividing the difference between the critical defect at the operating pressure and the critical depth at the test pressure by the calculated crack growth rate. Since such a definitive understanding is not currently achievable for most operating pipelines, consideration of safety factors which account for the associated uncertainty is also recommended.

5. *SCC Remedial Action:*

Plan Document: A written plan that details actions to be taken when the evaluation procedure finds that pipeline integrity has deteriorated to non-maintainable levels. This would include field procedures (or references to such) for the safe implementation of repair and retrofit procedures, coating replacement, and associated safety considerations. The plan should also detail procedures (or references to such) for incident response.

Comments: Repair and mitigation methods are discussed in Chapter 7. 49 CFR 190 through 199 requires each operator to prepare a response to leaks and failure incidents, including those caused by SCC. The response procedure identifies a qualified team who can recognize SCC failure and understand the information that should be recovered from the incident in order to expedite safe repair and extend the evaluation, as required, to adjacent pipe segments. If a section of pipe is removed, the pipe must be preserved for metallurgical analysis.

The following is not specifically required by the protocols but should be considered. It would be difficult to provide effective threat protection against SCC if such a program was not in place:

6. *SCC Education/Awareness:*

> A written procedure addressing an education/awareness program, especially for field personnel discussing SCC, the threat posed, causal and incident factors, and identification during direct examination. The procedure should address operator qualification in this regard, specifically in-house trained personnel, or a key third-party contact working with the organization that can readily recognize SCC.

Items 1, 2 and 5 above should be in evidence for all IM plans. To make any assessment of the threat posed by SCC, even when there is a presumption that the conditions for SCC do not exist for a pipeline, basic data collection and an initial assessment should be concluded. As a result of this initial exercise, and in the event that an operator concludes that the conditions for SCC are not identified, local site threat assessments (i.e. extension of item #2) would be obviated. Also, in this case, items 3 and 4 would not be required.

11.4 References

Eiber, R. J., and B.N Leis. 1998. *Protocol to Prioritize Sites for High-pH Stress-Corrosion Cracking on Gas Pipelines*. PRCI. Project PR-3-9403, L51864.

ChallengeUs.

This page intentionally left blank.

DRAFT

Challenge Us.